A new genus and species of Podapolipidae (Acari: Heterostigmata) parasitic on Physonota alutacea (Boheman) (Coleoptera: Chrysomelidae; Cassidinae) in Mexico and Central America

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Abstract

Cassidopolipus physonota gen. nov., sp. nov. (Acari: Podapolipidae) is described from the tortoise beetle, Physonota alutacea (Boheman, 1854) (Coleoptera: Chrysomelidae, Cassidinae) collected in Mexico, Honduras and Costa Rica. Of the thirty-one genera of Podapolipidae, the new genus belongs to a group of sixteen genera with adult females having just four well-developed legs. Within this group, six genera also have males with a short, mid dorsal genital capsule. Keys to the six genera are provided.

Key words: Taxonomy, tortoise beetle, insect parasite, new genus, new species

Introduction

Mites in the family Podapolipidae are common parasites of a number of families of Coleoptera, and less commonly on Blattodea and Orthoptera. The family is represented by one species each on Heteroptera and Hymenoptera. They have not been found on Diptera, Lepidoptera, Odonata or any aquatic insects. In most instances, each family of parasitized Coleoptera will have genera of Podapolipidae that are associated with that family only. A conspicuous exception is the genus Podapolipus, which is found on beetles in four families as well as on insects in the orders Blattodea and Orthoptera.

Materials and Methods

Examination of a large number of chrysomelid beetles representing primarily the subfamilies Chrysomelinae, Cassidinae and Hispinae in the collection of the University of Michigan Museum of Zoology (UMMZ) by the junior author over a number of years has yielded large numbers of mites, primarily belonging to the Astigmata (families Canestriniidae, Heterocoptidae, Histiostomatidae and Winterschmidtiidae). Among cassidine beetles, podapolipids were recovered only from one specimen of *Physonota alutacea*. Because no male mites were recovered in that collection, in 2013, the senior author examined another 98 beetles in the subfamily Cassidinae (Coleoptera: Chrysomelidae) in the UMMZ collection followed in 2014 by examination of 97 specimens of Cassidinae in the A. J. Cook Arthropod Research Collection of Michigan State University. Specimens of Podapolipidae were removed from the anterior abdominal tergites, and under the elytra, placed in 70% ethanol in vials and later on slides. Mites mounted on slides in Hoyer’s mounting medium were placed on a heated drying tray for five days and ringed with red insulating varnish.

Measurements were taken with a Zeiss compound phase contrast microscope with a stage micrometer. Measurements are given in micrometers (μm). Vestigial setae, i.e. those represented by alveoli without setal remnants are designated as “v”. Setae designated as microsetae (m) are no longer than the diameter of setal alveoli. Other terminology is based on Lindquist (1986).

Abbreviations for specimen depositories of the holotype and paratypes are: the A. J. Cook Arthropod Research Collection, Michigan State University, East Lansing, Michigan (CARC); The Acarology Laboratory, Museum of Biodiversity, The Ohio State University, Columbus, Ohio (OSAL); United States National Museum of Natural History, Washington, D. C. (NMNH) (mite collection housed in the USDA Systematic Entomology Laboratory, Beltsville, Maryland); National Museum of Nature and Science, Tsukuba 305-0005, Japan (NMNS); Queensland Museum, South Brisbane, Australia (QMBA); Tarbiat Modares University, Tehran, Iran (TMUI); Tamil Nadu Agricultural University, Coimbatore, India (TNAU); Coleccion Nacional de Acaros, Universidad Nacional Autonoma de Mexico, Mexico, D. F. (CNAC); University of Michigan Museum of Zoology, Ann Arbor, Michigan (UMMZ); Zoological Museum, University of Hamburg, Hamburg, Germany (ZMH).

Taxonomy

Podapolipidae Ewing, 1922

*Cassidopolipus* Husband and OConnor gen. nov. (Figs. 1–6)

Adult females with conspicuous stigmata, atria extending beyond the anterior border of the prodorsal plate, prodorsal plate with anterolateral projections. Prodorsal, C, D, and EF plates reticulate, undivided and with underlying alveoli-like structures, idiosoma with a pair of lateral lobes in engorged specimens, a pair of elongate posteroventral lobes, each with an inconspicuous, vestigial leg III near the base, with a well sclerotized genital apparatus with hooks at the end of the reproductive tract, legs I longer than legs II, femur I seta l” thick, extending to the base of tarsus I, with tibia I seta l”", tarsus I with hooked seta s, spinous seta pl" and dorsal seta tc", small clawless ambulacrum with a sucker; leg II anterior spinous seta tc’ and spinous seta u” with three prongs. Male with mid-dorsal genital capsule oval, with paired setae e on crescent-shaped plate EF, capsule not extending to the plane of
prodorsal setae $sc_2$, idiosomal setae other than setae $e$ vestigial, microsetae or not evident, tibia I setae $I'$ and $v'$ spinous, tibiae II, III with three setae, setae $I''$ not present. Larval female with cheliceral stylets longer than width of gnathosoma, with bases at anterolateral border of the gnathosoma, pharynx smaller than pharynx of adult female, plate D fused to larger plate C anteriomedially, prodorsal setae $v_1$ extend to bases of setae $sc_2$, setae $v_2$ vestigial, slightly posterior to setae $v_1$ and nearly in line with a line between bases of setae $v_1$ and $sc_2$, $sc_1$ not present. Setae $sc_2$ extending beyond the posterior margin of plate d, setae $c_1$, $c_2$ and $d$ vestigial, setae $e$ longer than legs III, bases of setae $h_1$, adjacent, $h_1$ longer than the width of the idiosoma, setae $h_2$ shorter than distance between setae $h_2$, tibiae I, II, III setae $d$ longer than combined length of leg segments F-G-Ti-Ta, coxal setae $1a$, $2a$ vestigial, $3b$ microsetae.

**FIGURE 1–3.** Cassidopolipus physonota Husband and OConnor *sp. nov.* (adult female). 1, dorsal; 2, leg I, dorsal; 3. leg II, dorsal.
Type species. *Cassidopolius physonota* sp. nov.

**Etymology.** The genus is named for the host subfamily Cassidinae (Chrysomelidae).

*Cassidopolius physonota* Husband and O'Connor sp. nov. (Figs. 1–6)

**Female** (Figs. 1, 2, 3, 4, n=10). Gnathosoma length 54–65, width 40–60 (Table 1). Cheliceral stylets 20–30. Pharynx thick, width 21–30. Palps longer than wide, two segmented.

**Idiosoma.** Length 300–440, width 228–340, with lobes lateral to prodorsal plate and plate C and with paired lobes seeming to arise on the posteroventral idiosoma. Subdermal structures similar to setal alveoli on reticulated plates PD, C, D, and EF. Mid-shield lengths for plates PD 40–75, C 45–80, D 40–65, EF 20–49. Stigmata posteriolateral to base of gnathosoma, with atria as long as prodorsal plate, with branching tracheoles. Distance between stigmata 60–92. Venter with well sclerotized internal structure with hooks at end of reproductive tract. Sternal apodeme and apodemes I, II well sclerotized.

**Legs.** Femur I with setae $l'$ thick, 15–25, tibia I with seta $l''$ 3–5, tarsus I with seta $r$ hooked, seta $pv$ m, seta $pl$ thin 5, seta $tc'$ with blunt apex 5. Seta $tc''$ spinous 5–6. Ambulacrum I sucker small, without a claw. Leg II smaller than leg I, tarsus II with terminal short, spinous setae $tc'$ and seta $u''$, $u'$ apex tripartite. Poorly sclerotized vestiges of two-segmented legs III occur ventrally, below the anterior margin of dorsal idiosomal plate EF.

**Male** (Figs. 5, 6, n= 5). Gnathosoma length 27–30, width 23–30. Cheliceral stylets 10–11, pharynx width 7–8, setae ch, su microsetae, palpi short, each of two segments with a short seta.

**Idiosoma.** Length 105–120, width 90–102, idiosomal setae $v$, $v'$, $v''$, setae $c_1$, $m$, setae $e$ 15. Distance between setae $v$ to $sc_2$. Setae $sc_2$ and $c_1$, m, setae $e$ 15. Distance between setae $v$–$v'$ 19, $sc_2$–$sc_2$ 33, $c_1$–$c_1$, $e$–$e$ 18, $c_1$–$c_1$, $e$–$e$ 13. Genital capsule mid–dorsal, oval. Setae $e$ located on a crescent-shaped plate EF anterior to the genital capsule.
**Legs.** Setation for femur, genu, tibia, tarsus of legs I, II, III; 3-1-5(+1)-8, 0-0-3-5, 0-0-3-5.

Tibia I, II, III setae $l'$ spinelike, tibial II, III setae $l''$ not present. Tibia I setae $v'$ spinelike. No setae on genua, femora II, III. Ambulacrum I with one stout claw, ambulacra II, III with no claws, each terminating in a prominent sucker.

**Larval female** (Fig. 7, n=10). Gnathosoma length 54–70, width 55–77. Cheliceral stylets 88–110, pharynx width 10–15. Setae $ch$ 40–50, $su$ 11–17, distance $su$–$su$ 25–38, palps two-segmented, with one short, thick seta on each segment.

**Idiosoma.** Length 155–237, width 130–198. Prodorsal seta $v_1$ 49–63, distance $v_1$–$v_1$ 50–60, $v_2$ vestigial, $sc_2$ 117–140, distance $sc_2$–$sc_2$ 76–84. Plate D fused with plate C anteromedially, $c_1$, $c_2$, $d$ vestigial, $c_2$ directly lateral to $c_1$. Seta $e$ 82–100, distance $e$–$e$ 28–36, seta $h_1$ 200–240, seta $h_2$ 2–5. Venter with apodemes weakly developed, apodemes II extending to sternal apodeme, coxal setae 1a, 2a vestigial, some specimens with vestigial 2b. Setae 3b microsetae.


**TABLE 1.** Maximum measurements in micrometers (μm) for *Cassidopolipus physonota* (*Cp*), *Tetrapolipus hunteri* (*Th*), *Buprestapolipus megachelus* (*Bm*), *Orthapolipus balboanae* (*Ob*), *Rhinopolipus lundi* (*Rl*), *Dilopolipus leei* (*Dl*).

<table>
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<tr>
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<th>Bm</th>
<th>Ob</th>
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<td>11</td>
<td>6</td>
<td>10</td>
<td>11</td>
<td>3</td>
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**Type material.** Holotype female: Mexico, Oaxaca, 2.41km SE El Cameron, 610 m, 15°53’34”N, 96°58’33”, from the wild olive tortoise beetle, *Physonota alutacea* (Boheman), 1854 (UMMZ), collected by I. J. Cantrall and T. J. Cohn, 14-IX-1959, BMOC 11-0220-046-1. Deposited in UMMZ. Paratypes 34 females, 50 larval females, 12 eggs with same data as holotype; four females, three males, three larval females, one vial with additional non-paratype mites, Mexico, Michoacan, La Huacan, from *P. alutacea*, collected by Reyes, Halffter, Edmonds, 4-VII-1967 (CARC); one adult female, one male, four larval females, one egg, Mexico, Jalisco, one mile N. San Gabriel, 4,000ft. elev., from *Physonota* sp., collected by James A. Peters, 30-III-1949 (CARC); two adult females, three males, three larval females, one vial with non-paratype mites, Mexico, Vera Cruz, Minatitlan, from *P. alutacea*, collected by R. & K. Driesbach, 26-VIII to 1-IX-1961 (CARC);
six adult females, seven larval females, one vial with additional non-paratype mites, Honduras, Choluteca, 0–10 km N Pespira, Teguchigalpa Rd., from *P. alutacea*, collected by T. H. Hubbell, 30-VII-1948, #167 (UMMZ); seven adult females, two males, two larval females, Honduras, La Ceiba, from *P. alutacea*, collected by G. V. Manley, 29-VII-1978 (CARC); one female, one larval female, Costa Rica, Guanacaste, Cañas, La Pacifica, from *Physonota* sp., collected by J. E. Zablony, 5-VI–1984 (CARC). One adult female, one larval female to each of the following institutions: OSAL, NMNH, NMNS, QMBA, TMUI, CNAC, ZMH. Five adult females, four males and five larval females to CARC. Five males to UMMZ. The balance of paratypes from *Physonota alutacea* collected from Mexico, Oaxaca, 2.41km SE El Cameron, to UMMZ. The balance of paratypes from Costa Rica, Honduras and paratypes from Jalisco, Michoacan and Vera Cruz locations, Mexico to CARC.

**FIGURE 6.** *Cassidopolipus physonota* Husband and OConnor sp. nov., male, ventral view.

**Etymology.** The species is named for the genus of the host species *Physonota alutacea*.

**Discussion**

Of 16 genera of Podapolipidae with adult females having only two pairs of prominent legs, six genera have males with circular or oval genital capsules mid-dorsal and not extending to the plane of prodorsal plate setae *sc*₂: *Tetrapolipus* (host Cerambycidae), *Rhinopolipus* (host Curculionidae), *Buprestapolipus* (host Buprestidae), *Dilopolipus* (host Scarabaeidae), *Orthapolipus* (host Tettigoniidae) and the genus described herein, *Cassidopolipus* (host Chrysomelidae). Adult females of the six genera have the gnathosomas broad and long styles. Female *Cassidopolipus* and
Orthapolipus have idiosomal lobes lateral to the prodorsal plate, and the other four genera do not. Larval female Cassidopolipus and Orthapolipus each have three setae on femur I and one seta on genu I (Table 2). The pattern of leg setation for the three pairs of legs varies considerably among the six genera above. The spinous form of tarsi II, III setae $tc'$ is present in male and larval female Cassidopolipus and in all other podapolipid genera except Chrysomelobia.

Males and larval females of Cassidopolipus lack tibia II, III setae $l'$. These setae are present in the first five genera mentioned above. Adult female Cassidopolipus have a unique sclerotized terminus of the genital tract and the paired posterior ventrolateral lobes are present only in adult female Cassidopolipus and Orthapolipus beeri Husband et al. (2005). The pair of vestigial, two-segmented, ventral legs III found near the region of plate EF of Cassidopolipus is also unique. Plates C, D and EF are undivided in female Cassidopolipus, Buprestapolipus and most Tetrapolipus, divided in female Dilopolipus and not present in female Rhinopolipus or Orthopolipus. The propodosoma of female Cassidopolipus is as broad as the opisthosoma at the level of Plate C, and

FIGURE 7. Cassidopolipus physonota Husband and O'Connor sp. nov., larval female, dorsal view on right, ventral view on left.

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legs II are not visible anterior to the prodorsal plate. The propodosomae in female *Buprestapolipus* and *Tetrapolipus* are narrower than the remainder of the idiosoma and legs II are visible anterior to the prodorsal plate. Setae $v_1$ and $e$ of larval female *Cassidopolipus* are longer than setae $v_1$ and $e$ of larval females of the genera above except for larval *Tetrapolipus seemani*. Larval female *T. seemani* are unique among podapolipid mites in having the idiosoma exceeding 500 micrometers, longer than the idiosomas of any other larval podapolipid mite. A rectangular idiosomal plate EF, with or without short setae $e$, occurs in males of several species of *Chrysomelobia* that have posterodorsal genital capsules. This plate is also present in male *Cassidopolipus* but is crescent-shaped with uniquely long setae.

**TABLE 2.** Leg setation for femur, genu, tibia, tarsus of legs I–III of larval female mites with adult females with two conspicuous pairs of legs and males with short mid-dorsal genital capsules. Solenidia are in parentheses. The genus *Curculipolipus* is included as the only other genus of Podapolipidae with tibiae II, III of larval females with three setae at present. Tibiae II, III setae $l$ of larval female *Chrysomelobia pagurus* Seeman 2008 are minute, and larval females of *C. verecundus* Seeman 2008 are not reported (Seeman, 2008). The potential exists for the discovery of larval instars of species of the genus *Chrysomelobia* with three tibiae II, III setae. Tibia I solenidion $\phi$ is designated distal (D), lateral (L) or proximal (P) in reference to its position in relation to tibial seta $d$. Tarsus I solenidion $\omega$ is designated distal (D), medial (M) or proximal (P) in relation to its position on tarsus I.

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<th>Leg I</th>
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<tr>
<td><em>Tetrapolipus</em></td>
<td>2 2</td>
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<td>7(+1D)</td>
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<td>3 1</td>
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<td><em>Orthopolipus</em></td>
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<td>6/7(+1L)</td>
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<tr>
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<td>6(+1L)</td>
<td>7(+1D)</td>
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<td><em>Dilopolipus</em></td>
<td>1 3</td>
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Although thousands of beetles from all continents except Antarctica have been examined for parasitic podapolipid mites by the authors and their colleagues, this effort represents a small fraction of one percent of Coleoptera that are potential hosts for mites in the family Podapolipidae. Similarly, publications dealing with biology or distribution of mites in the family Podapolipidae represent only a fraction of the studies devoted to the taxonomy of the family. It is not a common practice among entomologists to lift elytra of beetles to examine them for mites. In addition, tracheae and genital tracts of beetles and other insects are rarely examined for podapolipid mites such as *Locustacarus*.  

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and *Ovacarus*. We anticipate more discoveries and additions to the knowledge of this unusual family of obligate parasites of terrestrial insects as more insects are examined for them. Not many families show the range of adaptations to parasitism such as (1) reduction in instars from as many as five to two (egg to sexually mature adult male), (2) reduction of legs from 8 to 0 in adult females, (3) male genitalia ranging in position from posterior to dorsal to extending freely over the gnathosoma and (4) male genital capsules varying in shape from small and round to broad or narrow and elongate.

**Key to genera of female tetrapodid Podapolipidae with males with genital capsules terminating middorsally on fused opisthosomal plates C and D.** Numbers in () = number of species per genus.

**Key to genera of adult females**

1. Femur I seta *l*' elongate ......................................................... 2  
   - Femur I seta *l*' shorter than length of femur I or absent .................. 4  
2. Plates C, D. EF entire, reticulate surface ................................... 3  
   - Plates C, D. EF divided, smooth surface, host Scarabaeidae, New Guinea, Indonesia, (1) ... *Dilopolipus*  
3. Tibia II with seta *l*", idiosoma with narrow propodosoma and broad hysterosoma, without posteroventral lobes, without vestigial legs III, host Buprestidae, Central and South America (1) ... *Buprestapolipus*  
   - Tibia II without setae, idiosoma with propodosoma and hysterosoma equally broad, with posteroventral lobes, with vestigial legs III, host Chrysomelidae, Cassidinae, Mexico, Central America(1) .............................................. *Cassidopolipus gen. nov.*  
4. Without femur I seta. .................................................................... 5  
   - With short femur I seta, host Curculionidae, Guadalcanal Is., Pacific (1) ... *Rhinopolipus*  
5. Stigmata conspicuous, propodosoma as wide as hysterosoma, without opisthodorsal plates, host Tettigoniidae, Central and South America, Indonesia, Republic of Palau (4) ............... *Orthapolipus*  
   - Stigmata inconspicuous or absent, propodosoma narrower than hysterosoma, with or without opisthodorsal plates, host Cerambycidae, Central Africa, S. India, Sri Lanka, Malaysia, Indonesia, Philippines, New Guinea, Northern Australia (8) ............................................ *Tetrapolipus*

**Key to genera of larval females**

1. With one or two femur I setae ...................................................... 2  
   - With three femur I setae ................................................................ 4  
2. With one femur I setae and three genu I setae, with femur II seta *l*" and genu III *l*' ................... 3  
   - With two femur I setae and two genu I setae, without femur II seta *l*", without genu III *l*' , host Cerambycidae, Central Africa, S. Asia, Indonesia, Northern Australia (8) ...................... *Tetrapolipus*  
3. Gnathosomal seta *su* long, near two times distance *su*—*su*, setae *c*, *c*, *d* long, 11–28, host Buprestidae, Central and South America (1) ...................... *Buprestapolipus*  
   - Gnathosomal setae *su* short, near ½ distance *su*—*su*, setae *c*, *c*, *d* short, 3–8, host Scarabaeidae, New Guinea (1) .............................................................. *Dilopolipus*  
4. With four tibiae II, III setae, with femur II seta ................................... 5  
   - With three tibiae II, III setae, without femur II seta, host Chrysomelidae (Cassidinae), Mexico, Central America(1) .................................................. *Cassidopolipus gen. nov.*  
5. With genua II, III setae, gnathosomal seta *c*, *d*, *e* short, 6–8, host Tettigoniidae, Central and South America, Indonesia, Republic of Palau (4) ...................... *Orthapolipus*  
   - Without genua II, III setae, setae *c*, *d*, *e* long, 18–23, host Curculionidae, Guadalcanal Is., Pacific (1) ... .............................................................. *Rhinopolipus*

**Key to genera of males.**

1. With four tibia II, III setae, without idiosomal plate EF .......................... 2  
   - With three tibia II, III setae, with crescent-shaped plate EF and elongate setae *e*, host Chrysomelidae (Cassidinae), Mexico, Central Americ (1) ..................... *Cassidopolipus gen. nov.*
2 With femur II seta. ................................................................. 3
   – Without femur II setae, host Cerambycidae, Central Africa, S. Asia, Indonesia, Northern Australia (8) . .
   ................................................................. Tetrapolipus
3 With genua II, III setae. .......................................................... 4
   – Without genua II, III setae, host Curculionidae, Guadalcanal Is., Pacific (1) .............. Rhinopolipus
4 Setae $s_2$ vestigial or microseta. ............................................. 5
   – Length of setae $s_2$ nearly equal to length of distance between $s_2$, host Tettigoniidae, Central and South
   America, Indonesia, Republic of Palau (4) .................................................... Orthapolipus
5 Genital capsule in plane of setae $c_1$, tibia III setae, $v, v'$ no longer than width of tibia III, host Scarabaeidae,
   New Guinea(1) ............................................................... Dilopolipus
   – Genital capsule anterior to plane of setae $c_1$, tibia III setae $v, v'$ longer than length of leg distal to setae $v',
   v''$, host Buprestidae, Central and South America (1) ................................. Buprestapolipus

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http://dx.doi.org/10.1080/01647959908684169

from *Ceralces* sp. (Coleoptera: Chrysomelidae) from Tanzania, with a key to species of *Chrysomelobia*.


